LEVEL II

A MOBILE SURVEILLANCE SYSTEM FOR CEREBROSPINAL MENINGITIS CONTROL IN REMOTE RURAL AREAS

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A Mobile Surveillance System for

Cerebrospinal Meningitis Control in Remote Rural Areas

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SUMMARY

A mobile surveillance and control system was designed and tested during field operations in West Africa. The purposes of this exercise were two-fold: (a) to assist local and international medical authorities in defining and controlling an epidemic of cerebrospinal meningitis and (b) to perform applied field evaluation trials of a portable kit designed for rapid diagnosis of infectious diseases.

This operation was organized as a cooperative effort with the Ministry of Health of Upper Volta, Association pour la Promotion du la Medicine Preventive of Bobo-Dioulasso, U.V., and the World Health Organization. The problem involved coordinating case finding methods, rapid on-site specific diagnoses, and immediate vaccine distribution.

Effective use of specific vaccines to control epidemic cerebrospinal meningitis requires early, precise etiologic diagnosis of cases. However, since the first cases often occur in areas remote from medical laboratories, etiologic diagnosis is seldom possible. A portable laboratory kit has been developed for rapid diagnosis of infectious diseases, including cerebrospinal meningitis, under field conditions, and the logistics of administering meningococcal vaccines have been simplified by using jet injectors and stabilized meningococcal vaccines. A system employing these components for rapid diagnosis and vaccination was field-tested in Upper Volta with transport by a light plane.

The 1979 cerebrospinal meningitis epidemic was found to be due mainly to Gr. C meningococci, but other etiologic agents were also identified. Thus, Gr. C vaccine was used, and therapy for other infections could be made consistent with rapid diagnostic test results. This rapid diagnosis and vaccination system may provide a suitable model for control of cerebrospinal meningitis epidemics in the rural areas of of many countries. It may also serve as a useful model for an effective approach to epidemic control among expeditionary forces.

Background:

Modern vaccines have made possible the control of epidemic cerebrospinal meningitis (CSM) (5,7,9,12,15,18,19). This development is particularly important, since in some areas the etiologic agents of CSM may be drug-resistant (1). However, these vaccines are very etiologically specific (8,18). Therefore, in order to use vaccine for control of CSM epidemics, the specific etiologic agents should be identified precisely and early (9).

CSM epidemics have been recorded in Africa since the turn of the century (11). More recently, large CSM epidemics have occurred in South America. Outbreaks in recent years have also been reported from as widely-diverse locales as Finland, Mongolia, and Spain (18).

A related problem in recent years has been changing patterns of CSM etiology. For example, most of the earlier CSM epidemics in Africa were caused by serogroup A meningococci, but more recently, serogroup C meningococcal outbreaks have become increasingly common (20). Both serogroups were involved in the recent South American epidemics. While these serogroups also have been found in European outbreaks, serogroup B meningococcal meningitis also seems to be endemic there (18). There have also been Streptococcus pneumoniae meningitis outbreaks in Africa, as well as CSM outbreaks due to other etiologies (11).

This variety of etiologic agents in CSM poses serious problems to those planning vaccine control measures. Since the vaccines are etiologically specific, before they can be used for epidemic control, the etiology in any given CSM outbreak must first be precisely determined (15). Furthermore, timing of vaccinations is very important. Vaccines must be given early in an epidemic to achieve effective control (9). This points up the need for early, rapid diagnosis.

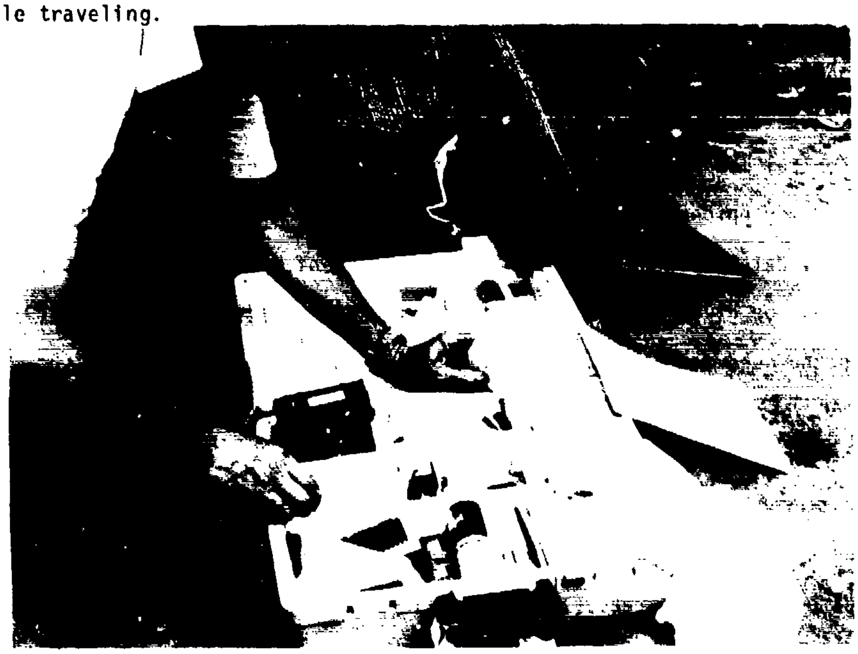
In many areas, as in sahelien Africa, CSM is essentially a rural disease. In many countries up to 80% of the population resides in small villages and family compounds scattered over the countryside. While many meningitis epidemics do occur in population centers, epidemics are more commonly composed of multiple small outbreaks, often located in remote areas (11). It follows that most CSM cases occur where etiologic diagnosis is difficult.

Fortunately, due to the World Health Organization smallpox eradication campaign, the logistics for effective vaccine distribution already exist in many areas. Jet-injectors are available, and their use is accepted by the people. Furthermore, well-trained vaccination teams exist in many areas, and various efficient indigenous transport methods exist to provide the necessary mobility for vaccine teams. Thus, it only remains to provide simplified, rapid diagnostic capability that can be applied in an effective and timely manner in remote rural areas.

Portable Rapid Diagnosis Kit:

A portable diagnostic laboratory kit has been developed to facilitate rapid diagnosis of infectious diseases. Simplified rapid diagnostic techniques have been incorporated into this kit to permit application of the kit in areas where conventional laboratory facilities do not exist (16).

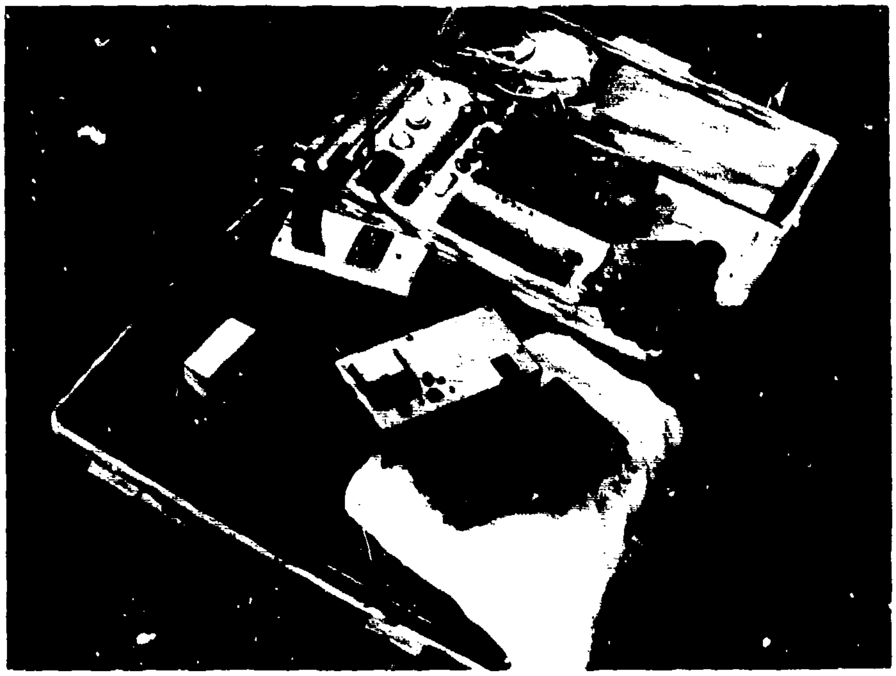
The kit is contained in a sturdy plastic case measuring about 47 x 39 x 21 cm, and it weighs approximately 13 kilograms (Figure 1). Equipment and supplies in the kit are shock-protected, and reagents are protected from temperature extremes in an insulated compartment. The kit is easily carried, and it fits under the seats of commercial aircraft, thus enabling public health workers to retain the kit in personal custody while traveling.



The portable diagnostic laboratory kit is contained in a compact plastic case that is easily carried and stored. (Figure 1).

All test systems in the kit are useful in CSM diagnosis. A miniature compound microscope is included along with all normal microscopy accessory supplies and differential stains. The counterimmunoelectrophoresis (CIE) system in the kit can be used to detect either antigens or antibodies in clinical specimens. The inert particle aggregation diagnostic system that is included can employ either latex agglutination (LA) or coagglutination (COAG) tests for rapid diagnosis of CSM (2,3,17).

When the kit is opened, the cover over the components can be used as a laboratory work table (Figure 2). Electrical components in the kit may be operated from 110 or 220 VAC mains or from a 12 VDC automobile battery, but for most test systems in the kit, electricity is not required. Other devices are included in the kit to aid in staining slides, reading test results, preserving specimens, purifying local water, and incubating cultures.



Components contained in the kit are shock and temperature-protected, and work may be done on the work surface included. (Figure 2).

Application of Kit Systems to CSM Diagnosis:

CIE, COAG, and LA tests have all been employed successfully by a variety of workers to make rapid diagnoses of CSM. Diagnostic applications include all the common bacterial etiologic agents; *N. meningitidis*, *Haemophilus influenzae*, and *Streptococcus pneumoniae* (2,3,13,21). Either antigens or antibodies may be detected and identified in clinical specimens using this portable rapid diagnostic kit.

Commercial reagents are available for diagnosis of CSM by any of these tests: CIE, LA or COAG. Furthermore, COAG reagents may be easily prepared using various commercially available antisera. Preparation of the staphylococcal suspension for COAG reagents is a simple matter (14), but if desired, stabilized protein A-containing staphylococcal suspension also may be obtained from various commercial sources.

Normally, CSM is diagnosed in any of these tests by detecting bacterial antigen in cerebrospinal fluid (CSF) or serum. Occasionally, antigen has been found in the urine of CSM patients (10,17). However, several workers have also demonstrated practical applications of CSM diagnosis by detecting antibodies in blood serum. The CIE test was used in this context during the first successful trial of serogroup A meningococcal vaccine in Egypt (19).

In bacteremic cases, some workers have found CIE and LA tests useful to examine blood serum for circulating antigen. These tests have even been employed to make prognostic predictions (4,6,10).

Field Application Studies:

A prototype system for early detection of meningitis epidemics and timely distribution of appropriate vaccine was field-tested in Upper Volta. The approach was based conceptually on a "circuit rider" system of mobile health workers commonly found in west Africa. However, several new elements were involved: telephone case-reporting; aircraft transport; rapid, specific etiologic diagnosis; and immediate vaccination.

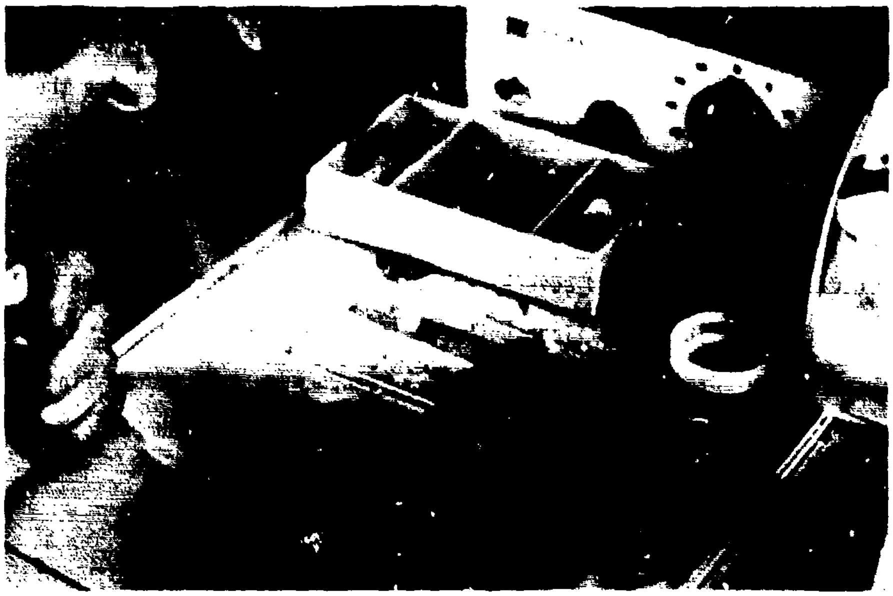
Early in 1979, the World Health Organization requested assistance for control of a meningitis epidemic in eastern Upper Volta. The problem as presented contained two parts: (a) The etiology of the meningitis epidemic was unknown, and (b) drug resistance had been observed clinically in meningitis cases. The task was to define the etiology of the epidemic so that appropriate, specific vaccines could be given in an attempt to control it.

The control system was planned to employ a light plane to search for meningitis outbreaks. This was more practical in west Africa than ground travel, since the epidemic area was large, and road transport was difficult. However, many small dirt airstrips or flat areas existed in this area that were suitable for landing a light plane near villages. The portable diagnostic kit was the means to determine the etiology of meningitis cases, and mass vaccinations in an area were accomplished by use of a portable jet injector.

The plane was loaded at Bobo-Dioulasso in western Upper Volta with the portable diagnostic kit, a jet injector, and several thousand doses of vaccine (Figure 3). The team flew east searching for village outbreaks that would define the leading edge of the westwardly-advancing epidemic. Several stops were made before finding an outbreak at Mahadaga in eastern Upper Volta. Here, there were a number of children in various stages of meningitis.

The items necessary for epidemic control by specific vaccination are vaccines, a jet injector, and a portable diagnostic kit; all easily carried in a light aircraft. (Figure 3).

The first step was to obtain CSF specimens by lumbar puncture. Then, the CIE test was set up to detect antigens of the etiologic agent in the CSF and to identify which specific type of bacterium was involved. (Figure 4). Battery power was obtained from a local truck to run the test. The COAG test was also used.



Rapid diagnostic tests are done using the cerebrospinal fluid or other specimens. (Figure 4).

Positive results in the CIE test appear as white precipitin lines in an agar gel on a slide. The procedure yields an answer within about 45 minutes of obtaining the specimen. The COAG test is simpler to perform, and it yields a diagnosis in about 5 minutes. In this case, it was determined that the epidemic was primarily due to serogroup C meningococci, but there were also cases due to S. pneumoniae and H. influenzae as well.

Thus, on the basis of the rapid diagnostic test findings, it was possible to choose serogroup C meningococcal vaccine to immunize the children of the entire area. Furthermore, it was also possible to recommend appropriate therapy changes for the patients with other infections. After completing the vaccinations, the search was continued for meningitis outbreaks at other villages.

In these field trials, the entire "system" functioned as anticipated. The newly installed Upper Volta telephone network was used to obtain preliminary outbreak information. Following consideration of the basic data, public health decision-makers proceeded to a logical, economical response. Then, case-finding for specific diagnosis, treatment, and vaccine distribution was efficiently pursued using a light aircraft. Essential etiologically specific diagnoses were providnd by the portable diagnostic kit, and portable jet injectors were used to quickly distribute specific vaccine (Figure 5).

Portable jet injectors can be used to quickly and efficiently immunize a population at risk. (Figure 5).

Discussion:

An appropriate public health "system" has been described for use in west Africa and similar areas. Meningitis control is a first, obvious application. However, a wide range of other diagnostic applications is also feasible with this kit. Using this portable diagnostic kit, precise etiologic diagnoses can now be made available in remote rural areas. Since appropriate control actions for many epidemic situations are already known, these control procedures then may be readily accomplished in a timely manner. This prototype "system" can serve as a useful model that responsible public health officials may apply to various problems in tropical infectious disease control (Figure 6).

APPROPRIATE TECHNOLOGY for EPIDEMIC CONTROL
in
RURAL AREAS

SYSTEM COMPONENTS

1. TELEPHONE or RADIO REPORTS
2. LIGHT AIRCRAFT TRANSPORT
3. PORTABLE RAPID DIAGNOSIS KIT
4. JET INJECTOR/VACCINES

PRIMARY FUNCTIONS

A. DETECT DISEASE OUTBREAKS
B. DEFINE ETIOLOGIC AGENTS
C. DELIVER MEDICAL RESPONSE

HEALTH CARE DELIVERY

INFECTIOUS DISEASE CONTROL

A mobile public health system for cerebrospinal meningitis control employs appropriate transport, rapid diagnosis, and efficient vaccine distribution. (Figure 6).

In conclusion, the existing logistic situations in many areas of the world seem very suited to attempts at control of epidemic CSM by specific immunization. Most of the necessary logistic factors already exist. The most pressing requirements remaining are: (a) specific diagnostic capability at regional and peripheral medical levels, (b) training of control and local health workers, and (c) field experience. Given a health care delivery system similar to the one described here, it may become possible even in rural areas, to detect disease outbreaks early, define their etiology precisely, and deliver appropriate medical response quickly. Thus, improved control of CSM and other acute tropical infections may be achieved.

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stabilized meningococcal vaccines. A system employing these components for rapid diagnosis and vaccination was field-tested in Upper Volta with transport by a light plane. The 1979 cerebrospinal meningitis epidemic was found to be due mainly to Gr. C meningococci, but other etiologic agents were also identified. Thus, Gr. C vaccine was used, and therapy for other infections could be made consistent with rapid diagnostic test results. This rapid diagnosis and vaccination system may provide a suitable model for control of cerebrospinal meningitis epidemics in the rural areas of many countries.